@
SB229
W5G3

F. # 1129

Cornell University Library
SB 229.W5G3

The cultivation of sugar cane in the Wes

3 1924 00

Cornell University Library

The original of this book is in
the Cornell University Library.

There are no known copyright restrictions in
the United States on the use of the text.

http://www.archive.org/details/cu31924000282198

The Cultivation of Sugar Cane

IN THE

WEST INDIES

PUBLISHED BY

AGRICULTURAL BUREAU

GERMAN KALI WORKS,

WEST INDIAN OFFICE

*

PRINTING OFFICE, 99 OBRAPIA STREET
HAVANA.

THIS PAMPHLET AS WELL AS THE FOLLOWING CAN BE OBTAINED FREE OF CHARGE BY WRITING TO

GERMAN KALI WORKS
P. O. Box 1007. 30 EMPEDRADO.
HAVANA, Cuba.

OR

P. O. Box 153, PORT-OF-SPAIN, Trinidad, B. W. I.

PUBLISHED IN

ENGLISH

- Bananas in the West Indies
- Cacao Culture in the West Indies
- Citrus Culture in the West Indies
- Coffee Culture in the West Indies
- Cotton Culture
- Fertilizer Guide for the West Indies
- Pineapple Culture in the West Indies
- Stassfurt Industry
- Miscellaneous Economic Plants in the West Indies
- Tobacco Culture in the West Indies.

SPANISH

- Cultivo de la Caña en las Antillas
- Cultivo del Café en las Antillas
- Cultivo de la Piña en las Antillas
- Cultivo del Tabaco en las Antillas
- El Cultivo del Cacao en las Antillas
- Guía de Fertilizantes para Uso en las Antillas
- Naranjos en las Antillas
- Diversas Plantas Utiles en las Antillas

FRENCH

- Guide des Engrais a l'Usage des Antilles
- La Potasse sous les Tropiques
- La Culture du Café aux Antilles
- La Culture du Tabac aux Antilles
- Les Bananiers aux Antilles
- La Culture de la Canne aux Antilles

CONTENTS

Page.

INTRODUCTION. 9

SUGAR CANE SOILS. 10

THE RED CORAL SOILS 10
BLACK SOILS WITH CALCAREOUS SUBSOIL 11
BLACK SOILS WITH HEAVY CLAY SUBSOIL 12
YELLOW AND BROWNISH CLAY SOILS 12
ALLUVIAL SOILS 14

PREPARATION OF THE LAND FOR PLANTING. 15

NEW LAND 15
WEEDY LAND 16
LEGUMINOUS CROPS AS AN AID IN PREPARING LAND 18

METHODS OF PLANTING. 21

FERTILIZERS. 23

SUGAR HOUSE AND BARNYARD REFUSE 24
GREEN MANURING 26
CHEMICAL FERTILIZERS 29
FIELD EXPERIMENTS 34
- In Cuba 40
- In Porto Rico 45
- In Jamaica 49
- In Barbados 53
- In the Leeward Islands 55
- In Trinidad. 56
- On the Mainland 59

CULTIVATION.
  - PLANT CANE CULTIVATION
  - RATOON CULTIVATION

TILLAGE IMPLEMENTS AND MOTIVE POWER.

DRAINAGE.

IRRIGATION.
  - METHODS OF APPLYING WATER

CANE VARIETIES.

DISEASES AND INSECTS.

MISCELLANEOUS INFORMATION.
  - LAND MEASURES
  - NUMBER OF PLANTS PER ACRE AT VARIOUS DISTANCES APART
  - MATERIALS FROM WHICH FERTILIZERS ARE MADE AND WHAT THEY CONTAIN
  - HOW TO CALCULATE THE AMOUNT OF FERTILIZER MATERIALS PER ACRE
  - MIXED FERTILIZERS

ILLUSTRATIONS

Page.

MUSCOVADO FACTORY, BARBADOS 8

CANE ON CUBAN RED SOILS,—FERTILIZED AND IRRIGATED 13

CONTINUOUS ROW SYSTEM OF PLANTING 20

DISTRIBUTING FERTILIZER BEFORE PLANTING 30

VIEW OF EXPERIMENT PLATS, MANACAS, CUBA 38

VIEW OF EXPERIMENT PLATS, MANACAS, CUBA 39

VIEW OF EXPERIMENT PLATS, MANACAS, CUBA 42

VIEW OF EXPERIMENT PLATS, CALIMETE, CUBA 46

VIEW OF EXPERIMENT PLATS, CALIMETE, CUBA 47

FERTILIZER EXPERIMENT, PETIT BOURG, MARTINIQUE 52

FIELD, WITH MAN IN FOREGROUND, WELL FERTILIZED. FIELD ON THE OTHER SIDE OF THE ROAD NOT FERTILIZED 54

FIELD OF YOUNG CANE 62

INFLUENCE OF MOISTURE ON GROWTH 68

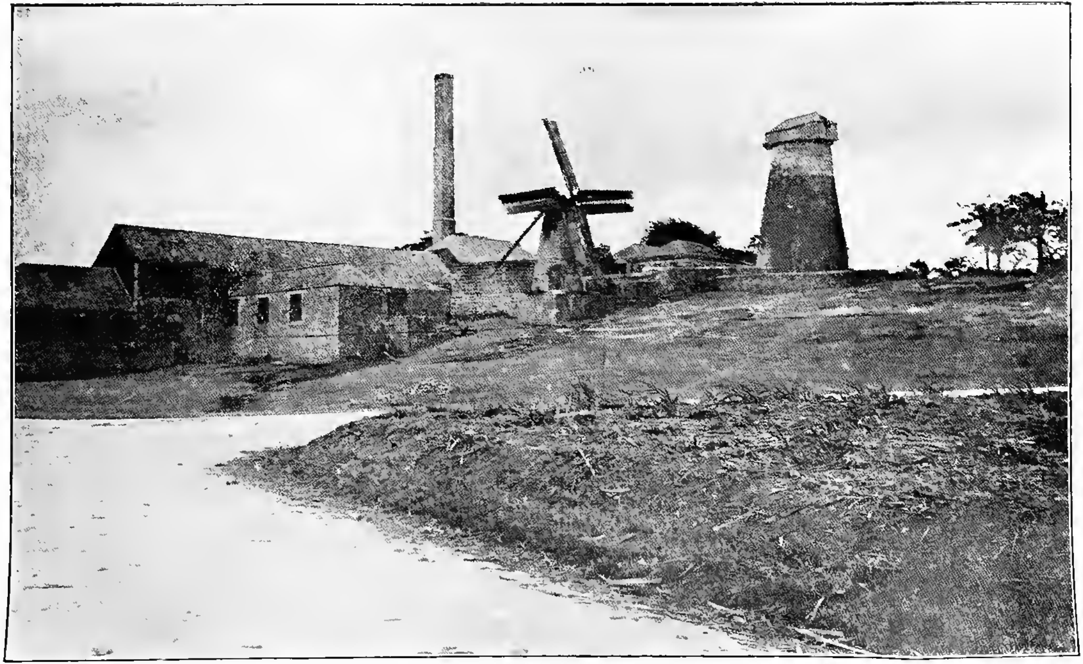
HYBRID CANES, BARBADOS EXPERIMENT STATION 70

CANE VARIETIES, HOPE GARDEN, JAMAICA 74

CANE VARIETIES, HOPE GARDEN, JAMAICA 75

CANE FACTORY, DEMERARA 77

VIEW OF FACTORY, PRESTON, CUBA 84



Muscovado Factory, Barbados.

INTRODUCTION

The basis of this pamphlet is a series of articles contributed to the "Cuba Magazine" by Professor F. S. Earle who was the first Director of the Estación Central Agronómica in Cuba and later consulting field expert to the Cuban-American Sugar Co. The original manuscript was found to be too long to be published in pamphlet form, and much valuable information had to be left out. However, the gentleman who made the revision, has lived in the West Indies for more than ten years, has visited all of the Islands, some of them several times, and is thoroughly familiar with cane growing in the different places.

All of the information given in this pamphlet is based on results obtained in the West Indies, and for that in the fertilizer section we are especially indebted to the Departments of Agriculture in the various Islands. We have purposely omitted to describe local methods that are of no interest to planters outside of a limited area, and which ought in most cases to be discarded by those who use them. Improved methods are needed in all agricultural operations in the West Indies and those described in this pamphlet ought to be helpful to all progressive cane planters.

SUGAR CANE SOILS

Cane can be grown in a great variety of soils, but it thrives best on rather heavy clay loams. On such soils it will endure long periods of drought, but frequent rains or irrigation are necessary for rapid growth. Standing water about the roots is very injurious. The principal cane soils of the West Indies may all be classified under some one of the following headings:

THE RED CORAL SOILS

These are soils of comparatively recent origin, apparently made **in situ** from the weathering and breaking down of the coral rock with which they are underlaid. They are usually quite level and constitute large areas in Cuba, Santo Domingo, Barbados and some of the other islands. These soils are heavy and very sticky when wet, but they are not a true clay, the bulk of the soil particles being large enough to class as silt. Their chief characteristic is their extreme permeability. Water passes through them so readily, that even after a heavy rain plowing and cultivation may begin often within twenty-four hours. There is no subsoil, the texture being the same down to the bed rock which, being porous and cavernous, serves to carry off surplus rainfall quickly, thus giving perfect natural under-drainage. There are few streams in the red lands, practically all the rainfall passing off by these underground passages. In places the soil has accumulated to a depth of many feet. Such areas are among the most desirable of all cane lands on account of their fertility and ease of cultivation. In other cases the soil is very thin, only filling cavities and depressions in the exposed bed rock. Even these rocky lands are fertile and produce good crops in seasons of abundant rainfall, but they quickly suffer from drought. Areas occur where this red soil has washed over and covered other older deposits. Here, of course, cultural conditions are modified by the presence of this subsoil, but such areas are infrequent. The red lands respond readily to the use of chemical fertilizers and when worn out or exhausted they may be readily improved by growing leguminous crops and plowing them under. On account of their perfect natural drainage no ditching is required, and level cultivation without ridging of the row is preferable. Owing to the extent to which animal labor can be employed during the rainy season, cane cultivation is usually cheaper on the red lands than on any of the other types. This ease and cheapness of cultivation is their greatest advantage, while a liability to suffer from prolonged drought is their only drawback.

BLACK SOILS WITH CALCAREOUS SUBSOIL

These occur over very large areas in Cuba where they constitute one of the most important types of cane soils. Geologically they are older than the red lands. They are usually rolling, or even sometimes quite hilly, so that surface drainage is good and extensive ditching is only necessary in the lower parts of the valleys. The top soil is a rather heavy clay loam of great natural fertility. It varies from only a few inches to as much as three to four feet in thickness. The substratum is a soft white material, locally known as "coco" that is largely composed of carbonate of lime. It hardens on exposure to the air, so that it is often cut out in blocks and used as building material. Although much less porous than the coral rock underlying the red lands, it is by no means impervious to water. Cane seldom suffers from water-logging on these soils while, on the other hand, they resist drought better than the red lands. On the steeper hillsides, when the top soil is thin, much damage is often done by washing rains. In the older fields whole areas are often exposed by the plow where the top soil has all been lost.

BLACK SOILS WITH HEAVY CLAY SUBSOIL

These are among the most fertile of all cane lands, but they are also the most difficult to cultivate satisfactorily. They are usually rather low and flat so that natural surface drainage is poor, and the subsoil is so stiff and retentive that practically no water can pass through it. Unless very thorough ditching is done, these soils remain so saturated with water throughout the entire rainy season that the cane is yellow and sickly and is often lost entirely.

YELLOW AND BROWNISH CLAY SOILS

This classification includes a great variety of soils. They are often very heavy and stiff, and when low and comparatively level they need bedding up. In other cases, especially in some of the so-called "mulatto" soils of Cuba, the texture is lighter and the cultural

Cane on Cuban Red Soils,—Fertilized and irrigated.

characters more nearly approach those of the red lands. In nearly all cases, however, even these lighter soils require more or less ditching. These lighter types of yellow or mulatto soils usually respond fairly well to chemical fertilizers, but the heavier clays, like the black lands, are especially benefited by stable manure, filter press cake, or by green manuring, all of which tend to modify and improve the physical texture.

ALLUVIAL SOILS

These are soils that have been deposited by running water. They occur along streams and form the flood plain at the base of mountains. They are usually dark in color, deep, and of a loamy, friable texture. On the second bottoms and higher benches they may be planted flat like the red lands, especially where underlying beds of gravel and sand give under drainage. On the lower levels they may require bedding up to carry off surplus water. In some localities these lands may carry too much sand or gravel for the best results with cane, but when this is not the case they are exceedingly fertile and productive. When old and worn they respond readily to chemical fertilizers.

Low lying, half marshy lands near the coast are often utilized for cane planting. These are really marine deposits, and they are heavier and stiffer than the true alluvial soils. Originally they were salt marshes or mangrove swamps that have finally become sufficiently elevated to lose most of their salt content by leaching. Of this character are the cane lands of Demerara and the so-called "poyal" lands of Porto Rico. Though stiff and untractable to handle, these soils produce heavy crops if sufficiently trenched and ditched. Hand trenching is often necessary on these lands, but much of the work can be performed by machinery.

PREPARATION OF THE LAND FOR PLANTING

NEW LAND

In the early days of the industry cane was almost always planted on new timber lands, and the preparation consisted simply in felling and burning the timber. Regions exist where timber lands are still available for planting, but a constantly increasing proportion of the world's cane supply is now grown on old lands that require expensive plowing and preparation before planting. When the new fields at last run out and require replanting, the cane planter encounters his first real agricultural problems. He must decide whether to attempt to plow and plant among the stumps, or to at once pull them up and thoroughly clear the land. The latter will be the wiser course if time and capital permit. Although the work will be expensive, it will be in the nature of a permanent improvement and, if done right, it will only have to be done once. If we count the waste of land, the breakage of implements, and the lodgement afforded for pernicious weeds and grasses, it will usually be found cheaper in the long run to dig out a stump at once and be done with it, rather than to plow and cultivate around it, even for a single season. The best way to get rid of stumps will largely depend on their size and abundance. Where stumps are small and stand close together, they may be economically pulled by some of the wire cable stump pulling tackles. If they are large and scattered, they had better be blown out with dynamite. Stump lands may often also be cleared by the aid of cable steam plows, using the implement as a "knifer".

The depth to which the land should be plowed, will depend on many things. Deep plowing is generally advisable on the red lands and on most alluvial lands, but with thin soils underlaid by stiff clay or by lime, shallow plowing is indicated and care should be taken not to go deep enough to turn up much of the subsoil. As a general rule, the land should be plowed sometime in advance of planting. Usually cross-plowing, and sometimes even a third plowing is necessary to get the land in the best condition. With a crop that is to last for a number of years, like cane, careless and slovenly preparation of the land is inexcusable. Most planters fail to give their lands sufficient harrowing. A fine seed bed is very important, especially for fall planted cane that has to stand through the dry season. If for any reason it is impossible to have the land thoroughly harrowed before planting, cultivation should begin at once between the rows, even before the cane germinates.

WEEDY LAND

Pasture and old cane fields that are infested with bad grasses, as: Pará grass (Panicum molle), also known as Panama grass, Yerba Bruja and Malojilla, Johnson grass (Sorghum halapense) and Bermuda grass (Cynodon dactylon), always require special treatment in preparing them for cane planting. Pará grass lands must be prepared during the dry season. Plowing during damp weather simply plants it, as every fragment buried in moist soil at once puts out roots and begins to grow. A Pará grass field should be cut with the mowing machine at the beginning of the dry season and when sufficiently dry it should be burned. The first breaking should be shallow, not over 4 inches, in order that pieces of stems be not deeply covered, and that the roots may be thoroughly exposed to the sun. After lying as much as three weeks it may be cross-plowed, this time going as deep as may be desired. Usually still a third plowing will be needed, and after the first rain, if any stray plants appear, they should be grubbed out and carried from the field. No half way measures should be permitted, for, if it gets established among the cane, the planting will have to be abandoned within two or three years.

With Johnson grass, on the contrary, repeated plowing during the wet weather seems to give best results. This grass does not grow from the joints like Pará, but is propagated by thick, fleshy underground stems. When these are broken by the plow during wet weather, they are more likely to rot than when the plowing is done in dry weather. Planting the ground to velvet beans for a season is also useful, since these vines climb up on the stems of the grass and weigh them down, so that they are finally buried and smothered. Close pasture to hogs is also useful in clearing land from Johnson grass, since they dig up and eat these fleshy underground stems. No method is known, however, that can be depended on to entirely free the land from this pest. Where it is once established, frequent cultivation will always be necessary to keep it from injuring the cane and considerable hand work is required to keep it down in the cane row. Pulling up by hand while the ground is soft will give much better results than cutting off with the hoe. When Johnson grass is cut off, it springs up again so quickly that the labor of hoeing is practically lost.

Bermuda grass is comparatively small and inconspicuous, but it forms so dense a sod that it really does more harm to the cane than the rank, coarse grasses above mentioned. Like Pará, every joint buried in the ground grows, and it is more resistant to drought and harder to kill than Pará. It cannot be killed at all by plowing in wet weather. It is best subdued by heavy shading. A thickly planted crop of cowpeas or velvet beans does much to smother it out. It does comparatively little damage in vigorously growing cane that closes in quickly so as to completely shade the ground, but in old cane that grows so slowly that the grass is allowed to form a sod, it does great damage and it is responsible for the running out of more cane fields than either of the other grasses.

LEGUMINOUS CROPS AS AN AID IN PREPARING LAND

Cowpeas and velvet beans have been mentioned in the preceding paragraphs. These and other legumes, particularly the Sword Bean (Canavalia ensiformis), the Gandul or Pidgeon Pea (Cajanus indicus), the Bengal Bean (Stizolobium atterrimum) and the Woolly Pyrol (Phaseolus mungo) may often be employed to great advantage in preparing land for planting to cane. Their manurial value is so great, due to their well known power of fixing and making available the atmospheric nitrogen by means of bacteria living in the tubercules on their roots, that some one of them should always be planted when a field of cane is plowed up before the land is again planted to cane. Aside from manurial value, such green cover crops have a very beneficial effect on the physical condition of stiff clay soils, making them much more mellow and friable. A single plowing in the spring, if the land is at once thickly planted to cowpeas, will often leave it mellow and in better condition for cane planting in the fall, than two or three plowings immediately before planting. Planters are all well aware that fall planted cane gives much better results than spring planted. The expense of cultivation is less and yields are much larger. The difficulty of preparing land during the rainy season always limits the amount of fall planting, even on the best drained lands, and on wet lands it is often impossible to do any fall planting. When old cane fields are plowed up during the winter and spring, it will often be found better and more economical to sow them down thickly to cowpeas at the coming of the first rains and hold them for early fall planting, rather than to rush them into cane again, and face the inevitable struggle with grass and weeds during the rainy season. To keep down weeds and grass successfully, the peas must be sown thickly, using from 1-½ to 2 bushels per acre. If Pará grass has not been successfully killed, the living clumps should be dug out and carried from the field, as they will outgrow and overrun the peas. Johnson grass too should be pulled up while the ground is still soft after the rains. If a good stand of peas has been secured, cane may be planted in August by simply opening up the

Continuous Row System of Planting.

deep planting furrows among the peas without any preliminary plowing. The few pea vines remaining between the rows will soon die out and will be cut up and covered by the subsequent cultivation. The land will be found mellower and in better condition, than any that has been recently plowed and prepared. If the cane is not all planted until after the cowpeas begin to die down and disappear, it will be best to cut them up and freshen the surface with a disk harrow before opening the planting furrows. In this method of planting the cane had best be covered by a two horse disk cultivator, so as not to pull out the buried pea vines, and the same implement will be found well adapted for the first cultivation. On very wet lands this method of holding the land for fall planting by the use of peas could only be followed when the land has been bedded up, since peas are easily drowned out in low places, and it is only where the stand is perfect that they can keep down the grass successfully. Even the wettest lands can probably be handled successfully in this way for fall planting if they are properly bedded up, for, even if the ground should remain too wet at the proper season for opening the planting furrows, the cane could be planted among the peas with a crowbar (jan), as in new (timbered) ground planting, and the pea vines could be cut up with the disk cultivator after the cane has germinated.

METHODS OF PLANTING

On timber lands the lines are usually staked off for planting at distances of 5 by 5 ft to 6 by 6 ft and the cane is planted by making a hole with an iron bar in which a piece is inserted. This is practical and fairly satisfactory, but it is a mistake to use the same method in old fields. Even the method of making large planting holes with a spade is antidated and unsatisfactory. A cane field should be plowed, harrowed with a disk harrow, cross plowed and harrowed again before planting, if it is possible to do so. After such preparation, deep furrows should be made with a double-mouldboard plow. This is perfectly safe, provided the drainage ditches are deeper than the furrow, and it is a safeguard against drought. Such furrows, 12 to 18 inches deep, can only be made with a strong plow and plenty of motive power, but it pays.

The distance of planting is a mooted question. The rows are usually 5 to 6 feet apart; greater distances have been advocated from time to time, but trials have usually demonstrated the fallacy of those theories. It is not yet determined how far apart the cane should be planted in the rows, but that will largely depend on the number of ratoon crops, the variety of cane and the character of the soil. It seems to have been fairly well demonstrated that cane planted in a continuous row produces a much larger yield and ripens more evenly than that planted some distance apart in the row. The continuous row system can be especially recommended for fields that are replanted often and, of course, also for varieties that do not ''stool'' freely and early.

In the continuous row system the seed cane is laid in the planting furrow, end to end, seldom overlapping.

Where vertical planting is necessary on account of extremely heavy soil, insects, or for other reasons, the pieces are planted upright about six inches apart through the whole length of the furrow.

The bedding up of the land is entirely a drainage problem. Where the drainage is perfect, it is a waste of labor to bed up, and where the rainfall is limited, the bedded cane suffers more from drought than that planted on the flat. If the drainage is not perfect, the land should certainly be bedded, because standing water around the roots for any length of time causes great injury to cane. One of the most up-to-date methods of bedding is to lay off the land in beds one rod wide, after the first plowing. Then use a two-wheeled road grader instead of a harrow, which pushes the earth up towards the centre of the beds. A second plowing and grading in the same direction will finish the beds in good shape for planting, and the cost will be about the same as for the ordinary harrowing and cross-plowing. Beds one rod wide give room for three rows five feet apart with 6-½ ft space between the outside rows for the water furrows. After all the work is finished, the water furrows can be cleaned out with a large double mouldboard plow, and there will be but little need of hand labor of any kind.

FERTILIZERS

The fortunate owners of new lands need not concern themselves with fertilizers, but the time ultimately arrives when the question of maintaining or of increasing the fertility of the soil, becomes one of the most important that can receive the attention of the planter. The time has long since arrived in most cane growing countries when the older fields fail to produce profitable crops without manuring. They must either be abandoned to pasturage, which involves the expense of transporting the cane from ever increasing distances, or the question of fertilizers must be faced and solved.

SUGAR HOUSE AND BARNYARD REFUSE

Filter press cake (cachaza) combined with the finer part of the bagasse ash from the furnaces makes a complete cane fertilizer, that can be used with great benefit on practically all cane soils. Unfortunately in too many cases these valuable products are allowed to go to waste. Where barnyard manure is not considered indispensable, as on the larger plantations in Cuba, Porto Rico and Santo Domingo, it is not usually handled in a systematic way. In other Islands where it is believed that cane cannot be grown without it, its value is frequently overestimated and its action is usually misunderstood.

There are three distinct reasons for applying barnyard manure to the soil: (1) It improves the physical condition. (2) It changes the bacterial action. (3) It adds plant food. With this distinctly in view a planter ought to be able to determine how much labor it will pay to expend on handling the manure. For improving the physical condition of the soil it is not profitable to cart grass and weeds from far off fields, just for the sake of bedding the corrals. These materials are just as valuable when plowed in where they grow as they will be after having been trampled upon by the animals.

The bacterial action of yard manure is probably of more importance than is generally considered, but a small amount spread over the field before plowing under the weeds, would be almost as beneficial, as if the grass had been carted to the yard and mixed with dung,. and then carted back again.

The plant food value of barnyard manure depends upon the food consumed by the animals, the kind of bedding used, and the manner in which it is preserved. If work animals are fed on Pará grass, for instance, the dung will contain no more plant food than the grass did. As a matter of fact, it will always contain considerably less, because of the unavoidable loss, and the amounts used by the animals for muscle production. If the animals are fed on pea vines and molasses, the dung will of course be more valuable, because those feeds contain more plant food. The same is true of the bedding materials. A grass contains no more plant food after having lain in the barnyard for some months than it did before. Of course, it is more disintegrated and in better condition for plants to feed upon, but no more so than if it had decayed in the soil. The actual plant food value of barnyard manure on the average cane plantation is very small, so small indeed that it would not pay to handle it for that alone. 20 to 40 lbs. of a chemical fertilizer costing 2-½ cents per lb. would supply as much nitrogen, potash and phosphoric acid as a ton of such manure.

Why, then, is barnyard manure so valuable that it is considered indispensable on many plantations? Simply because the soil is in such poor physical condition, that it will not produce cane without being improved, and, according to the old ideas of farm husbandry, stable manure is the only thing that will improve it. Fortunately, that is not so, but the fact remains that manure, wood ashes, and similar refuse from the plantation, have a certain value and should be saved.

GREEN MANURING

In the problem of conserving soil fertility, manuring with leguminous crops is the most important in the West Indies, since the quantity of stable manure and mill house refuse is limited, and will only serve for a small portion of the lands under cultivation, while leguminous crops can, and should, be grown in every field where the cane runs out, and has to be plowed up before it is again planted to cane. A full crop of cowpeas or velvet beans takes up in the neighborhood of 100 lbs. of atmospheric nitrogen per acre and fixes it in a form that will be available for subsequent crops. At current prices nitrogen in the form of commercial fertilizers is worth from 18 to 20 cents per pound. The actual money value as a fertilizer of a good crop of cowpeas is therefore about $18 to $20 per acre. This is the chemical value alone without counting the improved physical texture of the soil, that comes from incorporating so much easily fermentable vegetable matter. It has also been pointed out in a previous paragraph how a crop of legumes may be utilized for holding land that has been prepared during the dry season for planting the following fall, thus avoiding the unsatisfactory preparation of land for fall planting during the height of the rainy season.

Various leguminous crops are available for soil improvement in the West Indies. Of these, Cowpeas (Vigna catjang) are probably the most generally useful. They germinate quickly and cover the ground promptly, only requiring ten or twelve weeks for full development. The vines, when properly cured (without too much exposure to the sun) make excellent hay, or the peas may be gathered and utilized as food or for stock feeding. They may be planted at any time during the first half of the rainy season. They are often planted in drills, but it is usually best to broadcast them on cane lands, using about 1-½ bushels per acre. Cowpeas are sometimes planted interculturally between the rows at the beginning of the rainy season. Under certain conditions such plantings give good results. The peas shade the ground and obviate the necessity for further cultivation while their growth does not seem to injuriously affect the cane. The "Whip-poorwill" variety is the best kind to use for this purpose, since it does not make long vines to climb up on the cane. With closely planted cane the rows close in so quickly, that there is not time to get much benefit from the growth of the peas.

Velvet Beans (Macuna utilis) are a strong growing high climbing vine which, when unsupported, covers a field with a dense mass of tangled foliage. It is efficient as a nitrogen gatherer, and holds the land for a considerably longer period than the cowpea. It should be planted at the very beginning of the rainy season and will occupy the land until well into the following dry season. It makes good hay, but the vines are so long and tangled that it is difficult to cut and cure them. For the same reason they are more difficult to plow under than the cowpeas, but they can be successfully handled with a sharp disk plow.

The Sword Bean (Canavalia ensiformis) is another strong growing legume that promises to be very useful for green manuring. It grows erect to a height of four or five feet, and then produces some sprawling, vine-like arms. It occupies the land even longer than velvet beans under favorable conditions, living over, and continuing to grow the second year. It will make a heavier mass of vegetation than any of the others. To give the best results it should be planted in drills and be cultivated once or twice.

The Pidgeon Pea (Cajanus indicus) is usually planted as a food crop. If planted singly it grows into a large, spreading, half woody, bush reaching a height of 10 or 12 feet, and a diameter at the base of 2 to 3 inches, but if thickly broadcasted the stems grow slender enough so that they can be plowed under by using a heavy chain to drag them down. The seeds ripen during the dry season; they are good for food, and make fine feed for chickens, pigs and other domestic animals. Some strains are practically annuals, mostly dying down after the ripening of the seed, while others are perennial, and live and bear for several years.

The Lablab Bean (Dolichos lablab) is a climbing vine, resembling the velvet bean in habit, and can be successfully used for soil improvements. It grows well throughout the year, and when left to grow for twelve months or more, it produces a heavier mulch than any of the foregoing.

The Bengal Bean (Stizolobium atterimum), also called Philippine Bean and Lyon Bean, is a comparatively recent acquisition to the West Indies, but it is very promising as a green manure crop. It resembles the velvet bean in habit, but it is much more drought resistant than any of the foregoing.

CHEMICAL FERTILIZERS

While it is possible to maintain the supply of nitrogen in the soil by leguminous green manuring, the phosphoric acid and potash finally become exhausted, and then there is no recourse except in the use of chemical fertilizers. Since cane often occupies the land for a considerable number of years without planting, it is more difficult than with most other crops to maintain the nitrogen supply by green manuring alone, so this element also must often be applied. Fertilizers may be conveniently grouped in two classes according to their origin,—the organic fertilizers, like tankage, bone meal, fish scrap, cottonseed meal, etc., and the mineral or so called chemical fertilizers, including nitrate of soda, sulphate of ammonia, the various rock phosphates, basic slag, and the different potash salts. Whatever its source, a fertilizer, generally speaking, is only valuable for the number of pounds of nitrogen, phosphoric acid and potash which it actually contains. Nothing is more misleading than the prevailing custom of pricing fertilizers by the ton. It often happens, that low grade fertilizers that sell cheapest by the ton, are really the most expensive when the price is calculated on the number of pounds of these substances that the ton contains. It is much fairer for all

Distributing Fertilizer Before Planting.

parties concerned when prices are figured on the unit basis, that is for so much for each per cent of nitrogen, so much for each per cent of phosphoric acid, and so much for each per cent of potash.

Cane is not very exacting in its fertilizer requirements, but can utilize almost any kind of fertilizing material. It has a long growing season, so that there is time for slow acting fertilizers to become available. The source of the fertilizing materials therefore makes comparatively little difference to the cane planter, provided only it is of a nature as to be easily fermented in the soil, and so far as our present knowledge goes, he is wise who buys fertilizers in whatever form will give him the cheapest price per unit for nitrogen, phosphoric acid, and potash. Of course, nitrogen from such unfermentable sources as hair and leather scrap has very little fertilizer value. Unacidulated rock phosphate is very slowly available, but if it can be bought cheap enough it serves for the permanent improvement of the soil. Bones, to be readily available, should be very finely ground. Potash is usually employed in the form of sulphate for sugar cane, because of the supposition that the chlorine in the muriate of potash is not favorable to the formation of sugar. While we do not recommend a change, we would suggest practical experiments to prove the assertion. The indications are that muriate will increase the yield more than sulphate on heavy clay soils, and also on soils containing an abundance of lime.

A good general guide for the use of fertilizer is the soil moisture, and the chemical reaction of the soil itself. In dry regions the nitrogen should be in the form of nitrate of soda or sulphate of ammonia, and the phosphoric acid in the form of superphosphate. The potash in the form of sulphate can be used under any condition, but without sufficient moisture the best result cannot be obtained from either potash or phosphate. In regions of heavy rains the nitrate of soda, if used, should be applied in several applications, the sulphate of ammonia in two applications, but the organic materials may be applied together with potash and phosphate at the beginning of the growing season if well incorporated with the soil. In regard to the chemical reaction some soils will color blue litmus red, which indicates that they contain free acid, and fertilizers that do not cause acidity, such as nitrate of soda, dried blood, bone meal and basic slag, will in all probability give better results than sulphate of ammonia and acid phosphate.

Whatever the source and composition of the fertilizer, the time and method of its application are of the greatest importance. In practically all cases a liberal application should be made in the bottom of the furrow at the time of planting. In the case of fall planted cane, fertilizer so applied induces a deep rooting habit, that aids materially in carrying the young cane through the winter drought. Roots always develop most abundantly in the neighborhood of the best food supply. In the case of spring planted cane the application of the fertilizer in the furrow with the seed is equally important, for the simple reason, that the growing season is too short to receive the full benefit from it if the application is delayed until the cane is up. When irrigation is available so that the cane is kept in continuous growth for the full period of twelve to eighteen months, these considerations do not apply, and the time of application is of less importance, but without irrigation, under the ordinary West Indian climatic conditions, the improper time and method of application has very often been the cause of the failure to get satisfactory results from the use of chemical fertilizers.

Lime is often applied to land with great profit, but it is used to correct acidity and to improve the mechanical texture of the soil, rather than as a true fertilizer. The proper use of lime is strictly a local question, depending entirely on the character and condition of the soil. If a piece of blue litmus paper pressed into a sample of moist soil turns red, it indicates an acid condition and experiments with lime would be advisable. Heavy applications of lime should never be made except after preliminary experimentation, for its use is sometimes decidedly injurious.

The proportion of nitrogen, phosphoric acid and potash needed in a fertilizer is also a local question, depending on the nature and condition of the soil. It can only be absolutely decided by local experience. Soil analyses are useful and will throw some light on the problem, but soil experts now agree that it is unsafe to prescribe fertilizers on the evidence of soil analysis alone. Thus analyses show a sufficient percentage of phosphoric acid in nearly all Cuban cane soils, but in many localities experience shows this to be the substance most needed, that contained in the soil being in an unavailable form.

In Barbados and the Leeward Islands the conditions seem to be different. There the soil analyses show but small amounts of phosphoric acid in the soil, and yet it is only occasionally that phosphoric acid, when applied in combination with nitrogen and potash, gives remunerative returns.

That such conditions prevail serves to emphasize the necessity of local experiments. In the absence of specific information to the contrary, it is always wisest to use a fertilizer containing about equal percentages of the three ingredients, but where large amounts of fertilizer are used, well conducted field experiments will nearly always result in considerable saving.

The plant food requirements cannot be ascertained from a chemical analysis of the ripe cane, because it is well known that the growing plants contain more plant food than they do after ripening.

It was shown by Dr. Watts (1) that the ash of the green leaves contained 17.23% potash and 1.39% phosphoric acid, while the dry leaves (trash) contained but 6.49% potash and .93% phosphoric acid. The same matter was discussed by Prinsen Geerlings (2) who calls attention to the changes taking place in the ripening cane, especially in reference to potash.

FIELD EXPERIMENTS

Field experiments are often planned at Experiment

---

(1) Pamphlet 30, Imperial Department of Agriculture.

(2) International Sugar Journal, August 1911.

Stations so as to give information on a number of problems, and such work is naturally complicated and too scientific for the average planter, but a simple experiment as outlined below will be of great practical value.

For such an experiment select a field with uniform soil. Furrow it out for planting in the usual way, and measure off 5 one-twentieth of an acre plats, some distance from one side of the field, in the following manner: If the rows are 5 ft apart, measure off 108 ft. 11 inches in one row and place a stake. Count off 24 rows and measure the same distance in the twenty-fourth row, and place another stake. Then stretch a cord from one stake to the other, to mark the termination of all the rows. If the rows are 6 ft apart, they should be 90 ft. 9 inches long, and four rows will make one twentieth of an acre. Have 8 stout stakes, and place one at each end of the rows Nos. 5, 10, 15 and 20, which are the rows dividing the plats.

Plat No. 1	
	20 lbs. Sulphate of Ammonia
	8 ,, Sulphate of Potash

Division Row.	No Fertilizer
Plat No. 2	20 lbs. Sulphate of Ammonia 10 ,, Double Acid Phosphate
Division Row.	No Fertilizer
Plat No. 3	10 lbs. Double Acid Phosphate 8 ,, Sulphate of Potash
Division Row.	No Fertilizer
Plat No. 4	20 lbs. Sulphate of Ammonia 10 ,, Double Acid Phosphate 8 ,, Sulphate of Potash

Division Row. No Fertilizer

Plat No. 5

Check Plat

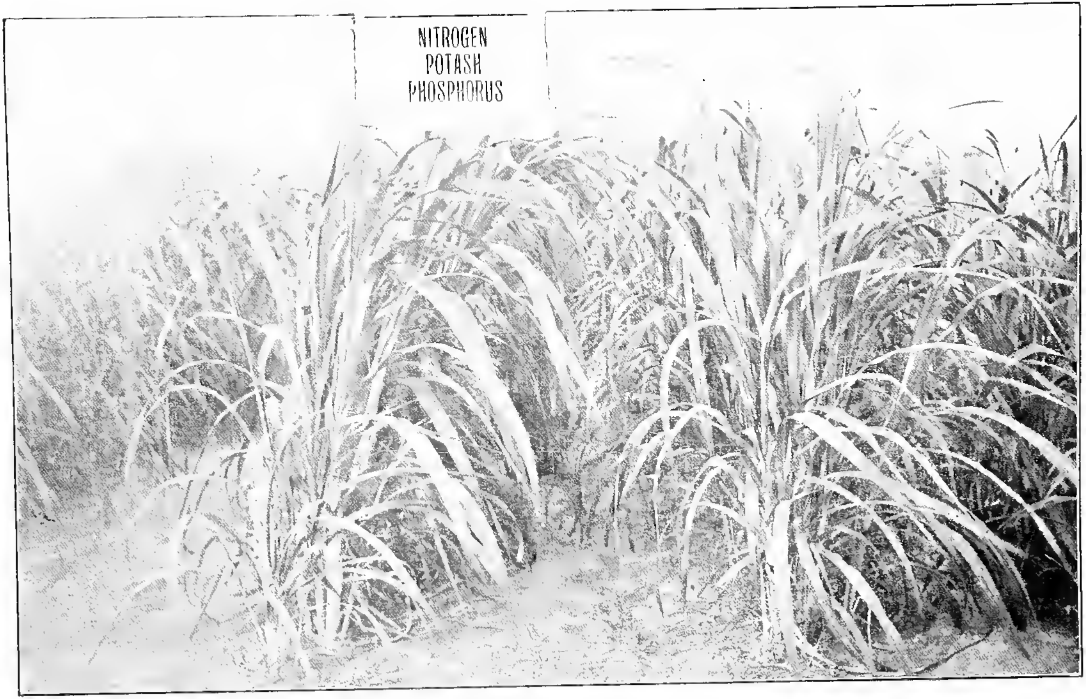
(Without fertilizer.)

After having staked off the plats, apply the fertilizers as indicated above, in the furrow, and mix well with the soil before planting the cane. If the experiments are to be conducted on ratoon cane, open a furrow on each side of the cane row, but not close enough to injure the ratoons, and apply the fertilizers in that. The division rows must, of course, not be fertilized. They may be planted with cane, but it is better to leave them without planting. The cane should be cultivated in the usual manner, and in harvesting, each plat should be cut and weighed separately. The division rows, if planted, should of course not be included in any of the plats.

Where the land is bedded up, it is most satisfactory to make each bed a plat, as the drainage ditches separating the plats are usually large enough to prevent the fertilizers from spreading from one to another. The plats can be made long or short, according to the width of the beds, and a small cross ditch is a very satisfactory means of separating the plats from the rest of the field.

In comparing the yields from the different plats, No. 1

View of Experiment Plats, Manacas, Cuba.



View of Experiment Plats, Manaças, Cuba.

compared with No. 5 will show the increase from the nitrogen and potash, No. 2 the increase from nitrogen and phosphate, No. 3 the increase from phosphate and potash and No. 4 from the three ingredients together. In comparing the four plats the relative importance of the three elements will be shown, and it will usually be found that one or two of them predominate, although the three together may give the largest yield.

After such preliminary experiments other questions often become of interest, such as: How much of each ingredient will it pay to apply? In what form should the different ones be? Should the nitrogen be in the form of sulphate of ammonia, nitrate of soda, or dried blood? Should the phosphoric acid be in the form of acid phosphate or basic slag? Would muriate of potash be as good as sulphate of potash? At what time should the different ones be applied, and should they be applied in one application or in two? These questions can be solved by field experiments similar to the one outlined above, but a great many plats will be needed. (1)

In some of the British Islands very extensive experiments have been carried on for a number of years. In Cuba and Porto Rico the available data are from a few years only, and from some of the Islands there are so far no data at all.

In Cuba experiments were started by the Estación

---

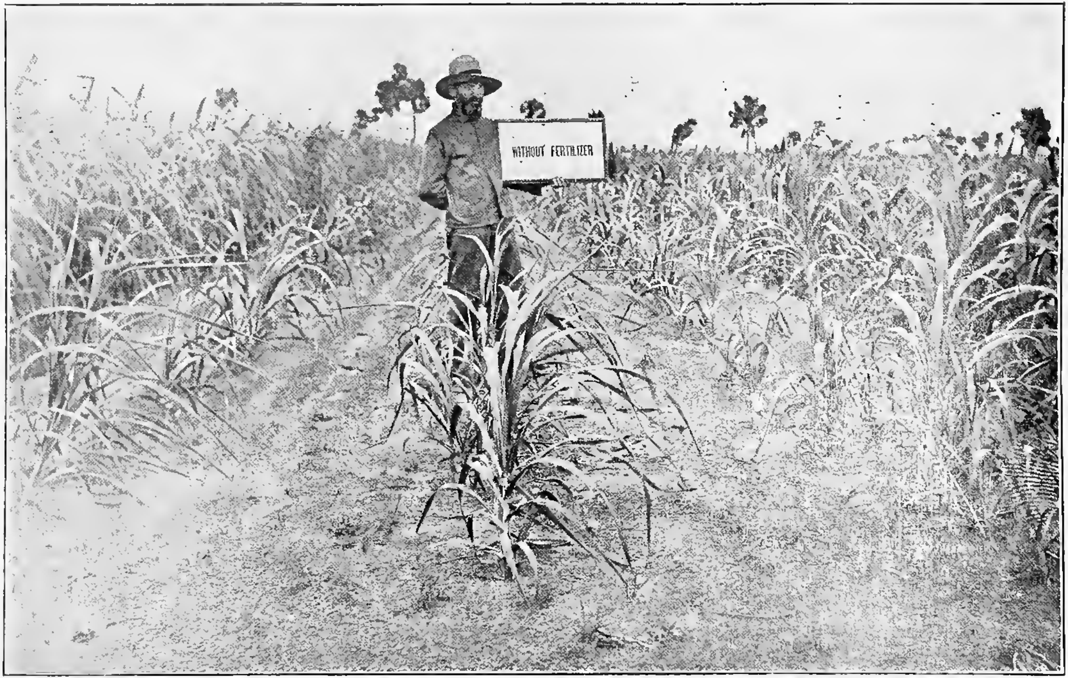
(1) Planters can often conduct experiments of this kind in cooperation with the Government Experiment Stations, and the German Kali Works are always willing to help with that kind of work.

Central Agronómica in 1904, both on the Station grounds, and in cooperation with planters. Bulletin No. 2 of that Station gives some of the results obtained, of which the following is an example:

		Yield in tons per acre.
Plat No. 1	No Fertilizer..................	31.46
Plat No. 2	20 lbs. Sulphate of Ammonia. 60 „ Acid Phosphate........	36.97
Plat No. 3	20 lbs. Sulphate of Ammonia. 60 „ Acid Phosphate........ 20 „ Sulphate of Potash....	39.07

The experiment was conducted on the Soledad Plantation in cooperation with the German Kali Works. The land was some of the oldest cultivated land on the estate.

During the last few years a great many experiments have been conducted in various places on the Island, the results of which vary according to soil and local conditions, but a summary of which shows that fertilizing is remunerative on the older cane lands. Nitrogen gives good returns on all of the old lands, except some of the black lands. Phosphoric acid seems to be universally needed, in the red soils especially, and that, when applied in combination with nitrogen, gives good returns. Potash is probably more needed in the black soils, but it produces a substantial increase in yield on some of the red soils also, when applied in combination with nitrogen and phosphoric acid, and a fair amount of it can therefore



View of Experiment Plats, Manacas, Cuba.

be safely included in any fertilizer formula, unless experience has shown that it is not needed.

Results from fertilizer experiments are often meaningless if the figures alone are considered, but the man who conducts the experiments, who has a chance to observe the errors due to slight differences in the soil, to irregular growth of the cane caused by insects, or "a thousand and one things", may often draw conclusions that cannot be set down on paper. Clear cut results in which the figures show all that there is to show are not usually obtained, except under ideal conditions. One such example is given below.

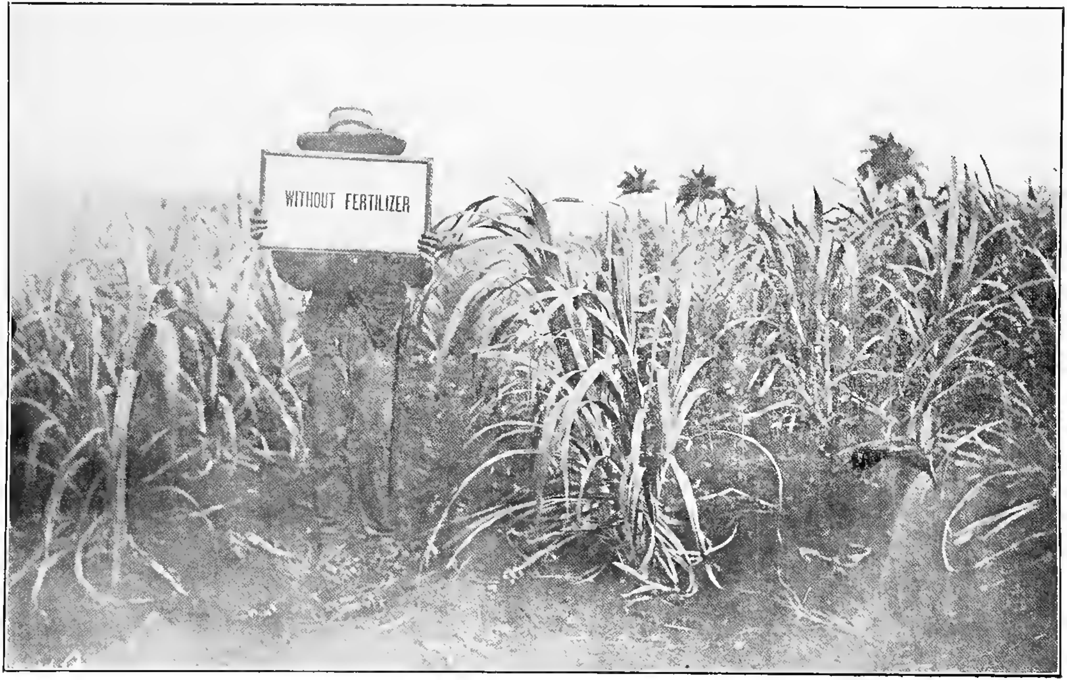
Experiment Conducted in Cooperation with Mr. J. Symes, San Marcos, Cuba.

The soil was a sandy loam, resting on yellow clay,—what is usually, in the West Indies, called savannah land, and considered unsuitable for sugar cane. The cane was planted in the fall of 1909, and fertilized with an ordinary cane fertilizer, containing about equal percentages of nitrogen, potash and phosphoric acid. It was harvested in the winter of 1910. The plats were layed off and the manurial experiment started in April 1911 on the first ratoon crop which was harvested in January 1912.

PLAT No.	MANURING PER ACRE	Cost of Manuring p. acre.	Yield p. acre in lbs.	Increase p. acre over unmanured in lbs.	Value of increase at $4.20 per 2000 lbs. of cane.	Profit p. acre due to manuring.
1	No Fertilizer		12567			
2	237 lbs. Nitrate of Soda 95 „ Sulph. of Ammonia 433 „ Basic Slag 114 „ Sulph. of Potash	$20.47	72150	59583	$125.12	$104.65
3	433 lbs. Basic Slag 114 „ Sulph. of Potash	$ 9.23	60666	48099	$101.01	$ 91.78
4	237 lbs. Nitrate of Soda 95 „ Sulph. of Ammonia 433 „ Basic Slag	$16.65	61534	48967	$102.82	$ 86.17
5	237 lbs. Nitrate of Soda 95 , Sulph. of Ammonai 114 „ Sulph. of Potash	$15.06	41816	29249	$ 61.42	$ 46.36

From experiments conducted at the Estación Central Agronómica, and reported in the Second Annual Report, it will be seen that the yields increased with increased applications, up to 80 lbs. each of nitrogen, potash and phosphoric acid per acre, after which there was no more gain. Larger applications may be found to increase the yield on other soils, but 80 to 100 lbs. per acre, corresponding to an application of 1000 lbs. of a 10-10-10 or an 8-8-8 formula, is about twice as much as what is usually applied.

In Porto Rico a number of experiments have been conducted by the Agricultural Experiment Station, and by the German Kali Works, in cooperation with planters. From the results of some of these, given by Director May in Bulletin No. 9 of that Station, it will be seen that remunerative results were not obtained with fertilizers wherever the land was not in good physical condition, or wherever there was not enough moisture present in the soil. At the Experiment Station where the soil is deficient in plant food, but where the land was properly prepared and cultivated, all the elements produced an increase in yield, whether they were applied singly or in combination. The increase was remunerative, except in two cases, as will be seen from the figures below which cover a series of experiments duplicated twenty times and continued for three years:



View of Experiment Plats, Calimete, Cuba.

View of Experiment Plats, Calimete, Cuba.

Increase in Yield Compared with Cost of Fertilizer.

		Gain in Yield per acre over Un-fertilized in Tons.	Cost of Fertilizer per acre.	Profit with Cane at $3.00 per ton.
Nitrogen alone	Plant Cane	4.18	$4.40	$8.14
	Ratoon „	2.81	$4.40	$4.03
Phosphorus alone	Plant Cane	2.70	$2.56	$5.54
	Ratoon „	3.04	$2.56	$6.56
Potash alone	Plant Cane	3.45	$3.44	$6.91
	Ratoon „	4.95	$3.44	$11.41
Nitrogen and Phosphorus	Plant Cane	5.72	$11.36	$5.80
	Ratoon „	5.10	$11.36	$4.06
Nitrogen and Potash	Plant Cane	5.35	$12.24	$3.81
	Ratoon „	6.18	$12.24	$6.30
Phosphorus and Potash	Plant Cane	2.79	$8.56	$ .19 Loss
	Ratoon „	5.11	$8.56	$6.77
Nitrogen, Phosphorus and Potash	Plant Cane	1.78	$10.40	$5.06 Loss
	Ratoon „	6.32	$10.40	$8.56

The results are unusual as far as the single elements are concerned, especially potash and phosphorus, which seldom produce substantial increases when applied to sugar cane alone or in combination without nitrogen. Nitrogen was, on that land, of greatest value on plant cane, while potash and phosphorus gave the greatest yield when applied to ratoon cane. The three elements together produced the largest yield, and also the greatest profit on ratoon cane, but for some reason they failed to do so on plant cane. However, from general experience Director May recommends a fertilizer containing about equal amounts of nitrogen, potash and phosphorus, except where information to the contrary is at hand.

In Jamaica very extensive experiments have been conducted by the Department of Agriculture during the last ten years, and the results are extremely valuable to the planters there. The experiments have not been confined to one or two localities, but the Department has gone out on the plantations in all parts of the Island where cane is grown, and has cooperated with planters, who were ready for instruction and eager to obtain information.

The results as given in the Third Report on that work show that some of the Jamaican soils are fertile enough to produce cane without manuring, while on others manure produces a substantial increase in yield and a handsome profit to the planters. In some instances the manures produced an increased yield, but not enough to pay for the cost, and the report is especially valuable, because yield, cost and profit are given in tabular form, examples of which are shown in the two following tables:

Manurial Experiment:

Crop Year 1908. Hyde Hall Estate—Trelawny.
Plats 1/10 Acre. Bullet Tree Piece.

PLAT No.	DESCRIPTION	PER ACRE						
		Basic Slag.	Nitrate of Soda.	Sulphate of Potash.	Cost in Shillings and Pence.	Tons of Cane per Acre.	INCREASE.	PROFIT.
		Cwt	Cwt	Cwt				
1	No Manure	—	—	—	—	16.1	—	
2	Complete	3	1-½	½	33/10	19.6	1.5	
3	No Nitrogen	3	—	½	15/6	14.6	—	
4	Double Nitrogen	3	3	½	52/1	16.6	0.5	
5	No Phosphate	—	1-½	½	24/2	16.5	0.4	
6	Double Phosphate	6	1-½	½	43/5	15.8	—	
7	No Potash	3	1-½	—	27/11	17.6	1.5	
8	Double Potash	3	1-½	1	39/8	21.0	4.9	9|4
9	Double Complete	6	3	1	67/8	21.2	5.1	

Period of growth—12 months.

Application of Manure—Novembre 1907. Crop reaped—June 1908.

Remarks—Rainfall June 1907 to June 1908 (inclusive) 32.6 inches.

Manurial Experiment:

Season 1908. Friendship Estate.

Plats 1/10 Acre. Plantain Walk Piece.

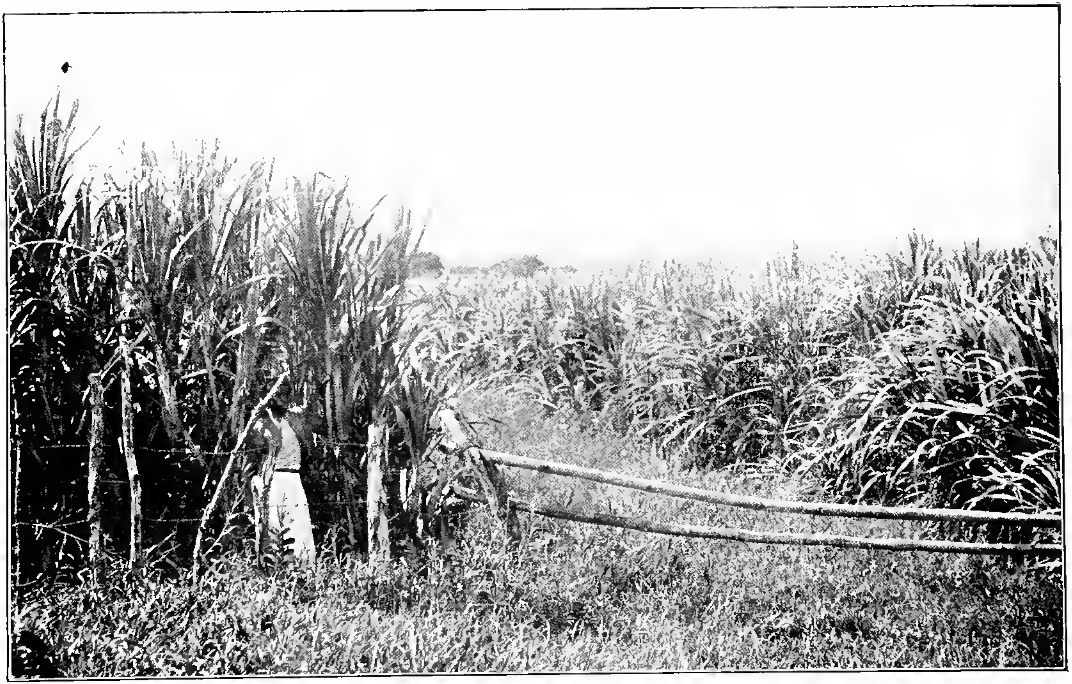
Basic Slag Series. Canes, Plants.

PLAT. No.	DESCRIPTION	PER ACRE						
		Basic Slag.	Nitrate of Soda.	Sulphate of Potash.	Cost in Shillings and Pence.	Tons of Cane.	Increase in Tons.	PROFIT.
		Cwt	Cwt	Cwt				
1	No Manure	—	—	—	—	22.0	—	—
2	Complete	3	1-½	½	33 /10	33.0	11.0	77 /2
3	No Nitrogen	3	—	½	15 /6	33.9	11.9	103 /6
4	Double Nitrogen	3	3	½	52 /1	37.2	15.2	99 /11
5	No Phosphate	—	1-½	½	24 /2	28.7	6.7	44 /10
6	Double Phosphate	6	1-½	½	43 /5	43.9	21.9	175 /7
7	No Potash	3	1-½	—	27 /11	33.2	11.2	84 /1
8	Double Potash	3	1-½	1	39 /8	40.8	18.8	148 /4
9	Double Complete	6	3	1	67 /8	49.5	27.5	207 /4
10	Lime	—	10	—	10 /—	37.9	15.9	149 /—

Period of grown—12 months.

Application of Manure—June 1st, 1907.

Rainfall—85.51 inches.

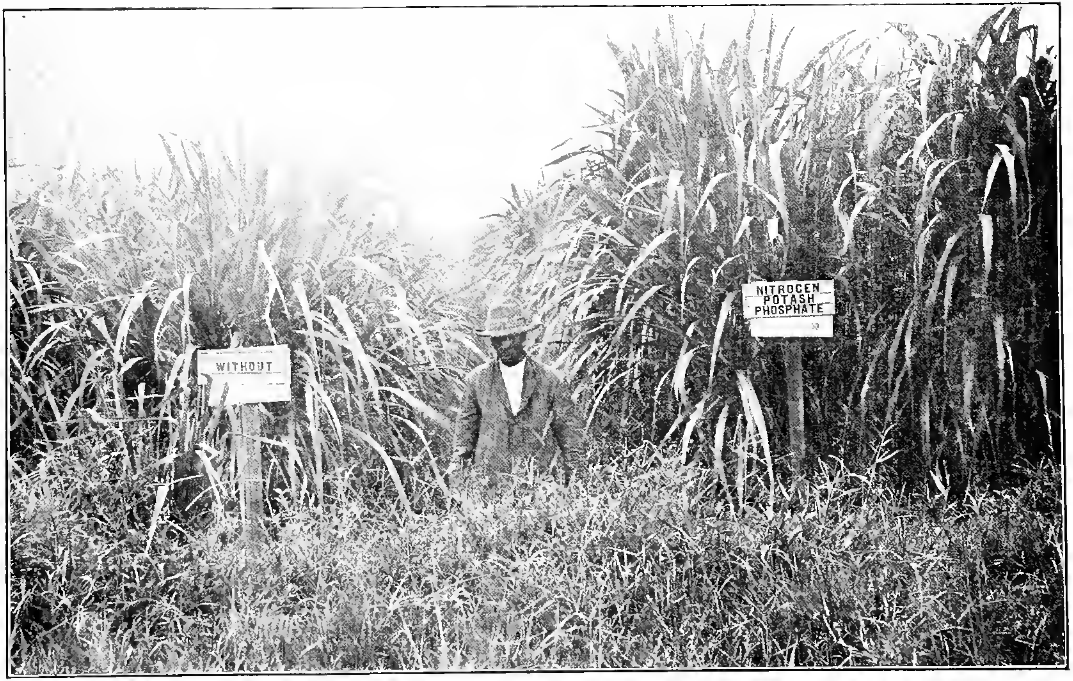


Fertilizer Experiment, Petit Bourg, Martinique.

In Barbados extensive experiments have been conducted by the Department of Agriculture for 18 years, and we have before us the report for 1910-1911 together with the average results for 18 years. The results are tabulated, so that not alone the tonnage, but also the actual money gain can be seen at a glance.

The soil at Dodds Experiment Station, where the experiments are conducted, is a rather heavy clay, and all the plats were dressed every year with 20 tons barnyard manure per acre. In addition to that, nitrogen, phosphoric acid and potash were applied in different forms, in varying quantity, and at different times. In regard to nitrogen, it was found that 60 lbs. of that in the form of dried blood gave slightly the largest yield, but because of its high price the actual gain was but about half of that where sulphate of ammonia was used. The gain from nitrate of soda was about equal to that from dried blood. Sulphate of ammonia at the rate of 300 lbs. per acre applied in January gave better results than smaller or larger quantities, although 200 lbs. applied partly in January, and partly in June, gave slightly the largest money return.

Phosphoric acid was found to decrease the yield of cane in some instances, and the loss of money caused by its use was as high as $12.38 per acre. Basic slag seemed best suited, and 500 lbs. per acre gave an increase of $1.96 per acre.



Field, With Man in Foreground, Well Fertilized. Field on the Other Side of the Road Not Fertilized.

Potash at the rate of 160 lbs. of sulphate of potash per acre applied in January, was found to give better results than smaller or larger quantities. The largest money gain, $27.21 per acre, was obtained where sulphate of ammonia and sulphate of potash were applied together in January.

In the Leeward Islands extensive experiments have also been conducted by the Imperial Department of Agriculture for a number of years, and it was soon found that chemical fertilizers were not remunerative on plant cane, provided barnyard manure could be obtained. On ratoon cane, nitrogen in the form of nitrate of soda or sulphate of ammonia gave pecuniary profit, and an early application gave better results as a whole, than where two applications were made.

Phosphoric acid and potash gave increased yields in some cases, for instance in St. Kitts, where nitrogen did not, unless it was applied together with potash and phosphate, but in many cases the returns were not remunerative even if the yield was increased. This is a very important point in fertilizing. The increase in yield from the use of fertilizers may be too small on account of a lack of moisture, which is probably often the case in the Leeward Islands. But even if there is an increase that would be called substantial where cane is worth $3.00 to $4.00 per ton, such an increase may result in an actual loss where cane is worth but $2.60.

The conditions in Barbados and the Leeward Islands are different from the rest of the West Indies in respect to manuring, because of the large amounts of barnyard manure. This cannot be obtained in quantities in the larger Islands. When no barnyard manure is available, Dr. Watts recommends the use of 150 to 200 lbs. of sulphate of ammonia or nitrate of soda, 75 to 100 lbs. of sulphate of potash, and 50 to 200 lbs. superphosphate per acre.

In Trinidad practical field work was started soon after the reorganization of the Department of Agriculture, and some results of practical value to the planters have already been obtained. We quote the results from two experiments which were reported to the Board of Agriculture in May 1912.

Manurial Experiments.

Frederick Estate, Caroni. Plant Canes, D. 109

PLAT - No.	Manures applied per plat (46.000 sq. ft.)	PER ACRE Cost of manuring.	Yield of Cane in tons.	Increase or decrease in tons.	Value of increase with cane at $2.40 per ton.	Profit or loss against unmanured.	
1	2 cwt Sulph. of Ammonia 1 „ Bone Meal ½ „ Sulphate of Potash	$10.49	30.83	15.45	$ 37.08	$ 26.59	GAIN
2	2 cwt Sulph. of Ammonia 1 „ Sulphate of Potash	$10.23	30.07	14.69	$ 35.26	$ 25.03	
3	3 cwt Calcium Cyanamide ½ „ Sulphate of Potash	$10.66	24.33	8.95	$ 21.48	$ 10.82	
4	1 cwt Sulph. of Ammonia ½ „ Nitrate of Soda 1 „ Superphosphate ½ „ Sulphate of Potash	$ 7.58	24.68	9.30	$ 22.32	$ 14.74	
5	4 cwt Calcium Nitrate 1 „ Superphosphate	$11.36	19.32	3.94	$ 9.46	$—1.90	LOSS
6	2 cwt Basic Slag 2 „ Nitrate of Soda	$ 7.48	15.28	—0.10	$—0.24	$—7.72	
7	10 cwt Temper Lime	$ 4.50	16.58	1.20	$ 2.88	$—1.62	
8	Control. No manure	......	15.38	......	....	....	
9	1 ton Temper Lime, air-slaked before applying	$ 8.32	15.65	0.27	$ 0.65	$—7.67	

Period of growth—18 months.
Application of Manure—June 11th. Crop reaped—May 12th.
Rainfall from June 11th to May 12th, 75.21 inches.

Manurial Experiments.

Malgretoute Estate, Princes Town. Plants B-156.

PLAT No.	Area of Plat in square feet.	Manures applied per plat.	PER ACRE					
			Cost of manuring.	Yield of cane in tons.	Increase or decrease in tons.	Value of increase with cane at $2.40 per ton.	Profit or Loss against average of Estate Plats.	
1	54000	2 cwt Sulph. Ammonia 1 ,, Bone Meal ½ ,, Sulph. of Potash	$ 9.14	31.84	3.02	$ 7.25	$ 7.71	GAIN
2	47000	2 cwt Sulph. Ammonia 1 ,, Sulph. of Potash	$10.24	44.83	16.01	$ 38.42	$ 37.78	
3	54000	3 cwt Cal. Cyanamide ½ ,, Sulph of Potash	$ 8.90	35.76	6.94	$ 16.66	$ 17.36	
4	54000	Estate Plat 4 cwt Peruvian Guano	$ 8.57	27.63	......	....	....	
5	30000	4 cwt Calcium Nitrate 1 ,, Superphosphate	$17.79	28.88	0.06	$ 0.14	$—8.05	LOSS
6	44000	2 cwt Basic Slag 2 ,, Nitrate of Soda	$ 7.61	22.42	—6.40	$—15.36	$—13.37	
7	43560	10 cwt Temper Lime 2 ,, Nitrate of Soda	$ 9.99	27.84	—0.98	$—2.35	$—2.74	
8	43560	Estate Plat 4 cwt Peruvian Guano	$10.63	30.02	......	....	....	
9	45000	1 ton Air slaked Temper Lime 2 cwt Sulph. Ammonia	$15.02	23.59	—5.23	$—12.55	$—17.97	
		Average of Estate Plats	$ 9.60	28.82	......	....	....	

Period of growth—17 months.
Rainfall May 1911 to May 1912. 45.87 inches.

In commenting on the foregoing figures the experimenter makes special mention of the splendid results obtained with potash. The experiments show conclusively that potash is needed in those soils. Furthermore, it is well demonstrated that sulphate of potash at the rate of 100 lbs. per acre, in connection with sulphate of ammonia at the rate of 200 lbs. per acre, can be applied and a handsome profit derived from it.

On the Main Land.—To illustrate conditions on the main land, we quote results obtained in Guatemala:

SUGAR CANE EXPERIMENT FIELD in **Samac, Coban, Guatemala. Canes planted in June 1903 on the triangular system.—Surface cultivation with the native hoe.**

No. of Plat.	Yearly Manuring per Acre.	Yield per Acre in Lbs.							
		First Canes 1905.	Ratoons 1906.	Ratoons 1907.	Ratoons 1908.	Ratoons 1909.	Ratoons 1910.	Total for Six Seasons.	Average.
1	Unmanured.	16046	15033	11172	10235	13047	17246	82779	13797
2	14-½ tons Barnyard Manure. . . . . . 327 lbs. Lime for 2 years.	19645	24145	14196	14509	21631	28117	122243	20374
3	89 lbs. High Grade Superphosphate =34 lbs. P_2O_5 109 „ Sulphate of Potash =56.2 lbs. K_2O 86 „ Sulphate of Ammonia =17 lbs. N	16720	20394	13121	12672	17883	18520	99310	16552
4	215 lbs. Peruvian Guano =45.6 lbs. P_2O_5 =17.0 lbs. N 111 „ Sulphate of Potash =56.7 lbs. K_2O	25418	33028	18969	19082	27105	27817	151419	25237
7	72 lbs. High Grade Superphosphate =26.1 lbs. P_2O_5 109 „ Sulphate of Potash =56.9 lbs. K_2O 146 „ Sulphate of Ammonia =30.0 lbs. N	35990	41426	28717	25080	46074	41576	218863	36477

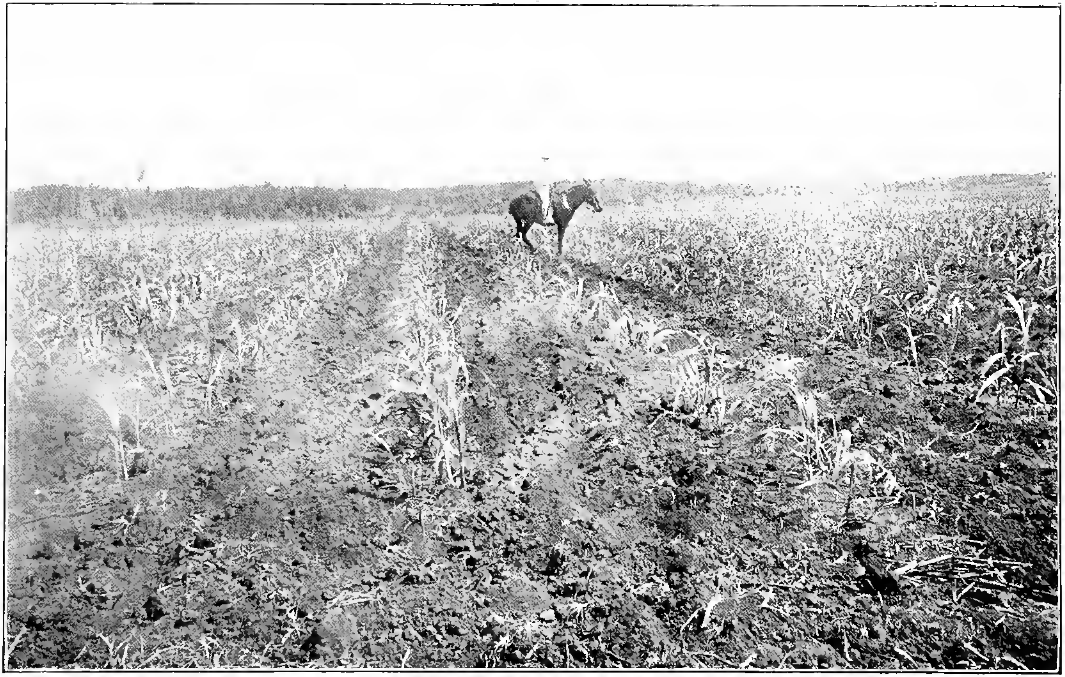
NEW EXPERIMENT PLAT in Samac Coban, Guatemala—Deep Cultivation with Plow. Seed planted closely in the furrows, rows 10 feet apart. Planted September 1, 1908. Manures applied once.

No. OF PLAT	MANURING PER ACRE	Yield per acre in Lbs.		TOTAL YIELD, 2 SEASONS.	AVERAGE.
		FIRST CANES 1910.	RATOONS 1911.		
8	72 lbs. High Grade Superphosphate =26.1 lbs. P_2O_5 109 „ Sulphate of Potash =56.9 lbs. K_2O 146 „ Sulphate of Ammonia =30.0 lbs. N 14-½ tons Bagasse Compost	122652	86874	209526	104763

CULTIVATION

PLANT CANE CULTIVATION

Plant cane usually requires more cultivation than ratoon. Unfortunately the principles which should govern tillage are not generally understood. Most planters are satisfied if sufficient tillage is given to keep down weeds and grass, but they fail to realize that this is only one of several objects to be attained by stirring the soil. Maintaining a dust mulch to conserve moisture, and aerating the soil to promote nitrification, are often more important even than killing weeds. With fall planted cane in particular, it is of vital importance to stir the



Field of Young Cane,—Note the continuous row system of planting, and clean cultivation with implements.

soil frequently enough to prevent its becoming hard, and baking after the last heavy rains. This is really the most vital time with fall planted cane. If the soil can be made mellow after the last heavy rainfall, then comparatively little more tillage will be needed. Every winter rain should immediately be followed by a cultivation in order to prevent crusting and baking, and a cultivator should be passed whenever the soil shows signs of cracking. Tillage should be shallow. Never plow or cultivate deeply after the cane has grown enough so that the roots begin to occupy the ground. This is especially important during dry weather. In the rainy season cultivate enough to keep down the weeds and grass. In the dry season cultivate enough to maintain a dust mulch and to prevent baking and cracking; when the cane closes so as to shade the ground, cultivation may be discontinued.

RATOON CULTIVATION

The presence of the trash (paja) left from the previous crop is always a serious complication in the cultivation of ratoon cane. This problem is sometimes solved by burning the trash soon after the field is cut; it can then be cultivated much the same as plant cane. Insect pests and diseases may cause special conditions which clearly make this course advisable, but in most parts of the West Indies, where vegetable matter is so much needed in the soil, the burning of the trash is very unwise, unless it is strictly necessary. Sometimes the trash is left as a mulch, covering the whole surface of the ground, giving nothing but hoe cultivation. This gives fine results on moist rich timber lands, but as the lands get old and more compact it is not satisfactory since the roots suffer from lack of aeration, and the fields only last for a few cuttings. Often the trash is moved by hand from the alternate middles, so that every other middle may be plowed and cultivated, while the other half receives a double mulch, which serves very effectually to hold moisture and keep down grass. This plan is very satisfactory, but where comparatively level cultivation is practised, it may be considerably cheapened by using a horse rake for moving the trash. The rake is driven across the rows, and it is dumped in each alternate middle. With a little practice a man soon learns to use it perfectly. The raking should be done as soon as the ratoons are up enough to show the rows, and the cleared middle should be at once plowed and cultivated down before the exposed ground has time to bake. A cultivator or small harrow should always follow immediately behind the plow, so that the clods may be pulverized before they have time to harden in the sun. The fertilizers should be applied and worked in at this time. Once the ground is thoroughly mellowed but little more work will be needed until the beginning of the rains, after which the ratoons will soon close. The double mulched middle will require no attention of any kind, except the pulling up or cutting off of such grass or weeds as may find their way through in the thinnest spots. No hoeing will be required except a little cleaning at the foot of the cane. At the first working it is always wise to throw a little earth on top of the row to cover up the cut cane stumps. It is very important that the cane be cut as close to the ground as possible.

TILLAGE IMPLEMENTS AND MOTIVE POWER

The reason why so few improved implements are used in the West Indies is mainly that people do not give them a thorough trial. A certain amount of skill is necessary for handling any kind of machinery, and it is money wasted to buy plows, cultivators and mules without having at least one good man to teach some of the more intelligent natives how to handle them.

The use of oxen and the old time turn plow are an improvement over the hoe and fork. The next step is the disk plow, disk harrow and tooth cultivator drawn by mules. The final development is specially constructed machinery drawn by oil engines.

The discussion of mules versus oxen would be too lengthy for this pamphlet, but mules are now being used very successfully both in Cuba and Porto Rico, and they are considered more satisfactory than oxen by those who have learned to handle them. The secret of success is proper feeding, washing, currying, and proper fitting of the harness. A very satisfactory and cheap feed is green grass or home made hay, cut up in a cutting box and mixed with 1 to 1-½ gallons of molasses, and one to one a half pounds of cotton seed meal, linseed meal or ground up cowpeas, velvet beans, etc. for each mule. Mules will keep in good condition on that when not working too hard. In the busy season they should be given an additional ration of oats, brewer's grain or mixed chops once a day. Of course, mules must also be curried every day, and cuts, sores and bruises must be attended to.

The harness, especially the collar, must be well fitted, and the driver should take care that the animals are not injured; with these precautions mules are better adapted for farm work in the tropics than any other animal.

Mechanical power is now successfully used in many places, and it is quite certain that, wherever it fails, the reason is a lack of knowledge. When the demand becomes greater the manufacturer will study local and special conditions, and supply machinery to fill the needs of all. There will also be more trained men, who will not only know how to operate the machinery, but also how to adapt it to special conditions.

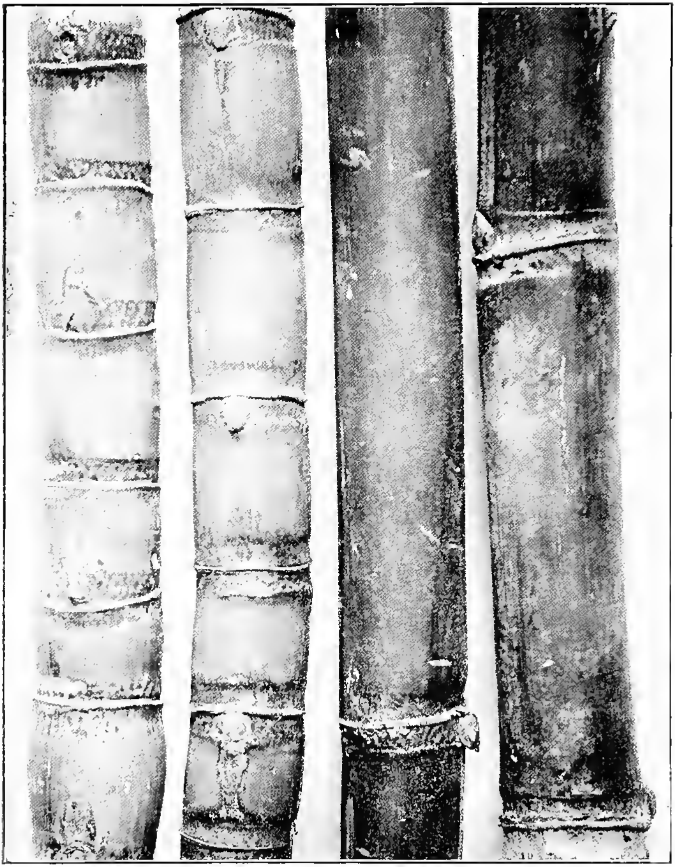
Cane soils are usually heavy, therefore strong and heavy machinery is needed. The plows especially should be strong, whether they be of the mouldboard or the disk type. An ordinary walking plow should have a share that will not cut over 12 inches or 14 inches at the most, and the mouldboard should be long and not too abruptly curved. A disk plow is very satisfactory if the soil is not too dry and hard, but it should be strong and have a fairly large disk, 28 inches being preferable to a 24 inch disk.

For harrowing, a good disk harrow is very satisfactory. For cultivating between the rows there are not many satisfactory implements. A one mule turning plow can be used to good advantage when the land is too grassy for a cultivator, otherwise a 5 to 7 inch tooth cultivator is best. Disk cultivators are also fairly satisfactory, but they must be built to suit local conditions in order to give the best results.

DRAINAGE

Drainage is a local problem, and it must be solved in a slightly different way according to soil and climatic conditions. Practically the only method used in the West Indies is surface drainage, and frequently one sixth, or more, of the land is non-productive on account of drainage ditches. This loss is greatly augmented by the difficulty of implemental tillage, and it makes the question of subsoil drainage extremely interesting. Subsoil drainage can unquestionably be made successful in many places if the system is properly constructed and maintained. The results from such work in the way of reduced cost of cultivation and increased yields look promising enough to be worth a good trial.

In digging and cleaning surface drains much labor can be saved by the use of a heavy double mouldboard plow drawn by oxen. For making large ditches, and for repairing field roads, a two-wheeled road grader is a most efficient implement. Where large drainage canals have to be cut through swampy lands, a special dredge or drainage machine that is built for this kind of service should be secured. Large areas of swamp land are being reclaimed in Louisiana by the use of such dredges. Cutting big ditches by hand through swampy lands is always too expensive.



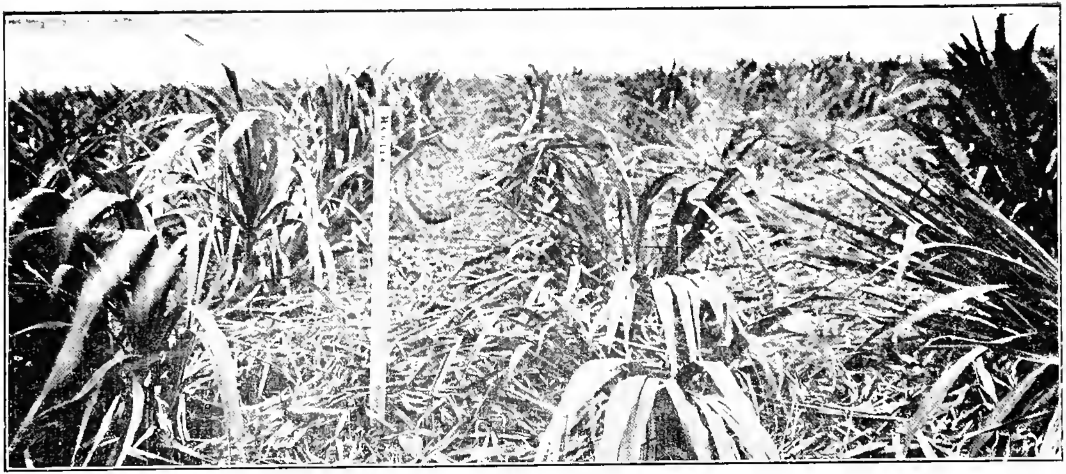
Influence of Moisture on Growth,—These pieces are all from one stalk of cane. The small joints show slow growth during the dry season. The long joints were formed after the rains started.

IRRIGATION

There are few districts in the West Indies where the judicious use of irrigation during the dry season would not increase the average yields from 50% to 100%, besides insuring the certainty and regularity of the cane supply for the mills. Irrigation too, permits the profitable use of much larger quantities of fertilizers, since these can only act beneficially in the presence of moisture for dissolving them.

The ideal method for irrigation is, of course, where water can be diverted from a running stream and brought in ditches by gravity. Such conditions exist in a great many places, and large sums are lost where the planter is shortsighted enough to let the opportunity go by.

Where running streams are not available or are insufficient, storage reservoirs may be constructed for catching and holding the storm water of the rainy season. Large dams for this purpose should only be undertaken under competent engineering supervision. If the locations for the dams are properly chosen, a comparatively small expenditure may often serve for impounding and holding a large amount of water. In building earthen dams the point of most importance is, to make sure of a spillway sufficiently large, so that no water can ever run over and cut out the dam. Of course suitable gates must be provided for drawing out the water as needed, which can then be carried to the fields in ditches, exactly as from running streams.



Hybrid Canes, Barbados Experiment Station. Some new varieties show peculiar habits. This one (No. 6114) starts growth almost horizontally.

When the topography is such, that irrigation by gravity is impossible or inconvenient, recourse may be had to pumping and the use of pipe lines for forcing the water up to the highest part of the land, from which point it may be handled in ditches by gravity.

There are various styles of pumps from which to choose for irrigation purposes. Centrifugal pumps are usually the cheapest to install, and they are quite satisfactory where the lift is low. Rotary pumps are also much used. For heavy work, especially with high lifts, the large, double acting, triplex, suction pumps will usually prove most durable and satisfactory, although the initial cost is greater than with other kinds.

Power for pumping will naturally depend largely on the local prices of different classes of fuel. In most parts of the West Indies, Producer gas will be found decidedly cheaper than either steam or gasoline. Those cane plantations which manufacture alcohol will find this a very satisfactory fuel; engines especially adapted to the use of alcohol must of course be used.

METHODS OF APPLYING WATER

From whatever source the water is obtained, the methods of distribution and application in the field will be practically the same. Borders may be thrown up on grade lines in such a way, that one section of the field after another can be completely flooded. This is seldom done as it requires a large supply of water. Frequently a main supply ditch is made at the upper side of the field. The cane is then planted in deep furrows running at right angles to this ditch, and it is irrigated by running the water directly in the planting furrow, the whole width of the field. The ratoon crops are banked up by plowing the earth towards the rows and the water is then distributed in the furrow between the rows. This method is simple, but it is subject to disadvantages, such as loss of water, overwatering in places where the field is not level, and washing where the grades are too steep.

A much more even distribution is secured by the so called Hawaiian method, which is now being widely adopted in Porto Rico also. In this method the planting furrows are run parallel with the supply ditch and as nearly on grade lines as possible. They are crossed by light water furrows every 30 or 40 feet. The water is taken down these water furrows from the main ditch, and is allowed to run into first one and then another of the planting furrows until each is uniformly filled to the desired depth, when it is cut into the next. The required amount of water is thus left standing in each planting furrow until it soaks away. Each part of the row receives the same quantity of water, and there is no washing out of the cane roots. So far as the economical use and distribution of the water are concerned, this system is really perfect. The water furrows crossing the rows at such frequent intervals, however, make cultivation with animals very difficult. In fact, under this system it is seldom attempted, the ground being kept clean with the hoe until the cane closes in. Notwithstanding its many advantages, this hindrance to tillage, with benefits which follow from it, make it still seem an open question which is the better system to follow.

CANE VARIETIES

It is well recognized now among the more progressive planters, that there is no such a thing as a best variety of cane. Certain varieties are more suitable to certain localities than others, depending on soil, climate and method of cultivation. This is being taken advantage of in some Islands, but it seems to be ignored by a large number of planters. Many are yet satisfied with the variety their grandfathers grew, the good old Bourbon, while others search the dictionary for words in which to express their disdain for it. These divergent opinions are largely held because of a misunderstanding of cane varieties in general. It is not always recognized that cane varieties are not stable, that is, some of the characters are lost or amplified during many years' cultivation in a certain locality, or a certain field. Therefore, when one planter speaks well of a certain variety, and another condemns it, both may be right.

This fact is of great importance to cane planters, as it emphasizes the necessity of constant selection. A planter who finds by experiment that a certain variety like Rose Bamboo (Crystalina), or B-208, B-147, D-95, White Transparent, etc., gives the best result on his land, is not through just because he plants such a variety. He must constantly select his seed cane from such plants as show the parent characters, or an improvement on those. It is not good policy to plant everything and anything as most planters do at the present time. A man for selecting seed

Cane Varieties, Hope Garden, Jamaica, (B. 147).

Cane Varieties, Hope Garden, Jamaica, (B. 208).

cane in the field would be just as profitable as the chemist in the factory.

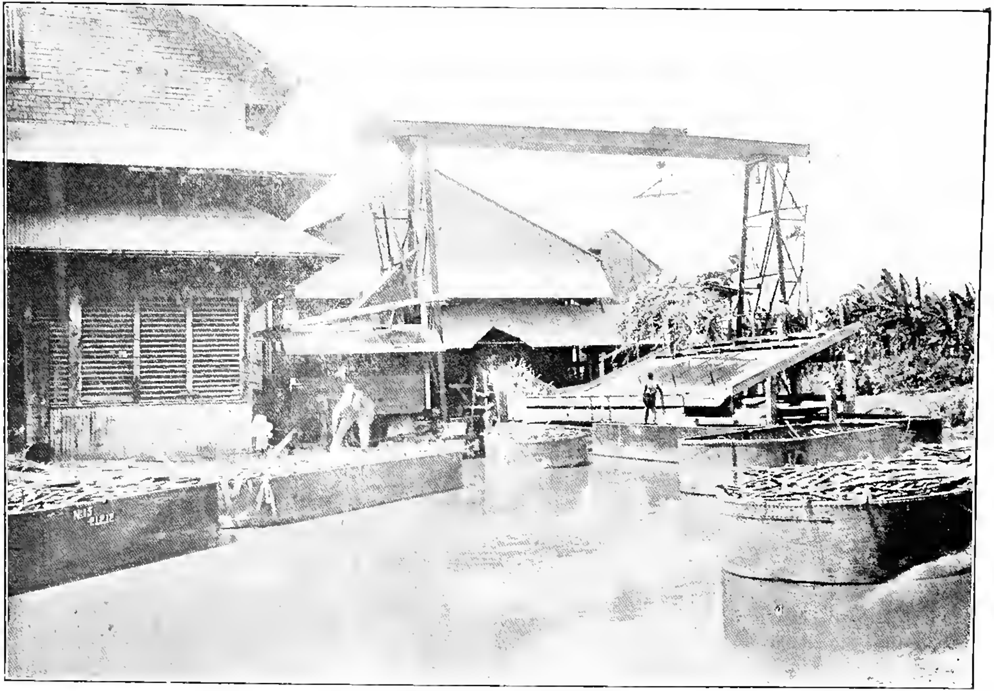
Of course the first thing is to find out which varieties are best suited to the different soils in the different Islands, and that is work which no government can afford to neglect, or should refuse to do. Those who are already doing this and who, furthermore, are constantly originating new strains, should be recognized as real benefactors of the cane planter.

DISEASES AND INSECTS

To describe the various diseases and insects encountered in the different Islands, and to prescribe remedies for them is not within the scope of this pamphlet. We take the opportuniy, however, of making some common sense suggestions.

There are three main things to consider, viz. fungus diseases, insect pests and physiological derangements, and all of them have this in common, that prevention is much easier than cure.

Of fungus diseases, the cane rot (Marasmius) is the most common. It attacks the roots of the cane, and can be detected by its white mycelium under the lower leaf sheaths, that is, a white webby mass surrounding the lower end of the cane stems as well as the roots. The usual remedy for fungus diseases is spraying with Bordeaux mixture, a copper-lime solution, but that is not practical in cane fields. The only practical methods are those of prevention, such as planting the varieties that



Cane Factory, Demerara. Unloading Cane from Canal Barges.

are most resistant, keeping the fields in a high state of cultivation, and the liberal use of commercial fertilizers. With these precautions the loss from fungus diseases will be greatly lessened. The trouble known as "drying of cane" may be caused by a fungus, but it is usually worse on certain unfavorable soils, and it has been demonstrated that it can in some cases be prevented by heavy applications of fertilizers.

The remedies for insects are different, according to their habit of feeding, but the usual remedies of stomach poisons for leaf-eating insects, and contact remedies for sucking and boring insects, are not practical in cane fields. The cane borer, for instance, cannot be practically kept in check by such remedies, neither can the Mealy Bug, the May beetle, nor the Froghopper. The only practical remedies are natural enemies. It is well known that birds and lizards destroy many insects, and planters everywhere should cast their vote for bird protection. The gun, the trap and the mongoose should be tabooed, at least as far as the birds are concerned, in the West Indies. Besides the useful agents mentioned, some insects are destroyed by fungus diseases and other insects, a knowledge of which can usually be obtained from the Entomologist and Mycologist of the Department of Agriculture. The preventatives are rotation of crops, planting clean seed, a high state of cultivation, and manuring. Rotation of crops is almost unknown in the West Indies, because it is not considered practical. Nevertheless, it is usually both practical and remunerative to keep the land in legumes for a season, every time the cane is replanted. To plant clean seed is not difficult because cane will stand soaking for a considerable time in solutions strong enough to kill most insects. Information regarding such solutions can always be hand from the local Department of Agriculture. Cultivation and manuring act both directly and indirectly. Insects can often be kept in check by cultivation alone, and certain insects such as the grub of the May beetle, may be killed outright by a fairly large application of Kainit. The indirect action is, that cane cultivated and well manured, makes such growth that a little injury is not noticed. It is also well known that vigorous plants in good growing condition are not attacked by insects and fungi to the same extent, as those that are half starved and making just enough growth to keep alive.

Physiological derangements are such as are caused by unsuitable soil, drought, weeds and an overabundance of water, a lack of proper plant food, etc., and the remedy is a knowledge of cane cultivation. If this pamphlet may even in a small measure help to disseminate such knowledge, it will have served its purpose.

MISCELLANEOUS INFORMATION

LAND MEASURES

1 Acre contains 43,560 square feet or 4,047 square meters.
1 Hectare contains 10,000 square meters or 2.471 Acres.
1 Acre contains approximately 208 feet x 208 feet.
1 Cuerda contains 42,307 square feet.

NUMBER OF PLANTS PER ACRE AT VARIOUS DISTANCES APART

Distance Apart.	Number per Acre.
5 ft by 5 ft.	1,742
5-½ ” ” 5-½ ”	1,440
6 ” ” 6 ”	1,210
6-½ ” ” 6-½ ”	1,031
5 ” ” 6 ”	1,452
5 ” ” 7 ”	1,244
6 ” ” 7 ”	1,037
7 ” ” 7 ”	888

MATERIALS FROM WHICH FERTILIZERS ARE MADE AND WHAT THEY CONTAIN

Materials used as sources of Potash	Containing Potash %	Available Phosphoric Acid %	Nitrogen %
Sulphate of Potash, High Grade (with 0.3 to 0.5% Chlorine)	48-55		
Sulphate of Potash Magnesia	27		
Muriate of Potash	48-55		
Kainit	12.4		
Materials used as sources of Phosphoric Acid			
Acid Phosphate		13-16	
Double Acid Phosphate (American)		40-45	
Double Acid Phosphate (European)		30-35	
Dissolved Bone		13-16	.5-1.5
Ground Bone		5-15	.5-3
Basic Slag		18-20	
Materials used as sources of Nitrogen			
Nitrate of Soda			14-16
Sulphate of Ammonia			18-20
Nitrate of Lime			18-20
Dried Blood (according to grade)			10-14
Tankage (according to grade and physical condition)		5-10	5-10

N. B.—If Nitrogen is stated as Ammonia, multiply by 0.82 or divide by 1.21, in order to obtain the actual amount of nitrogen.

HOW TO CALCULATE THE AMOUNT OF FERTILIZER PER ACRE

When experience has shown what amounts of nitrogen, potash and phosphoric acid it will pay to apply, the amounts of materials supplying these ingredients can readily be calculated. Suppose that 60 pounds of nitrogen are required. This can be supplied by using 400 lbs.

of nitrate of soda, because nitrate of soda contains an average of 15%, or 15 lbs. of nitrogen per 100 lbs. Of sulphate of ammonia only 300 lbs. would be required, because that contains 20%, or 20 lbs. per 100 lbs. If 80 lbs. of potash are needed, it will be necessary to apply but 160 lbs. sulphate or muriate of potash because those materials contain 50% of potash. To supply 60 lbs. of phosphoric acid, for instance, 400 lbs. acid phosphate would be needed of the 15% grade, but of the 40% grade only 150 lbs. would be required.

A mixture frequently used for cane is 200 lbs. sulphate of ammonia, 100 lbs. sulphate of potash and 250 lbs. acid phosphate, also called superphosphate. That mixture actually contains 40 lbs. nitrogen, 50 lbs. potash and 30 lbs. phosphoric acid. Another common mixture is 300 lbs. nitrate of soda, 300 lbs. basic slag and 150 lbs. sulphate of potash, containing 45 lbs. nitrogen, 60 lbs. phosphoric acid and 75 lbs. potash.

MIXED FERTILIZERS

The manufacturers of mixed fertilizers print the formula on the outside of the sacks, showing how many per cent of potash, nitrogen and phosphoric acid the mixture contains, and it is then sold and bought by the ton. A short ton of such a mixture with a formula of 4.5% nitrogen, 6% phosphoric acid and 7.5% potash will contain the following amounts:

Nitrogen 4.5%—4.5 lbs. in 100 lbs.—45 lbs. in 1000 lbs. —90 lbs. in 2000.

Phosphoric Acid 6%—6 lbs. in 100 lbs.—60 lbs. in 1000 lbs. 120 lbs. in 2000 lbs.

Potash 7.5%—7.5 lbs. in 100 lbs.—75 lbs. in 1000 lbs.—150 lbs. in 2000 lbs.

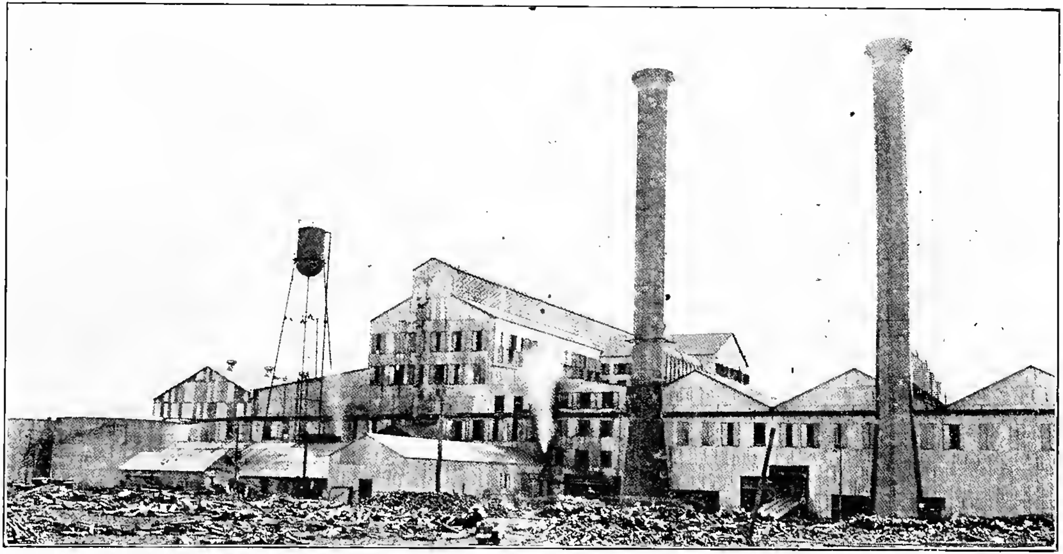
This, as will be seen, is equal to the mixture mentioned in former paragraph made from 300 lbs. nitrate of soda, 300 lbs. basic slag and 150 lbs. sulphate of potash. Only the amounts are double, making 600 + 600 + 300 = 1500 lbs. In order to make the mixture weigh 2000 lbs., the manufacturer may add 500 lbs. of sand or any dry earth.

A mixed fertilizer, especially European mixtures, are frequently sold on the unit basis, that is, the price charged is according to the amounts of plant food contained in the mixture, those amounts being stated in units. A unit of a ton is 20 lbs. In other words, it is one per cent—1 lb. in 100 lbs.,—10 lbs. in 1000 lbs.,—20 lbs. in 2000 lbs. Referring to the mixture above it will be seen that it contains:

Nitrogen, 4.5 units — ...... 90 lbs. (4.5 x 20 = 90)
Phosphoric Acid 6 units — . 120 „ (6 x 20 = 120)
Potash 7.5 units — .... 150 „ (7.5 x 20 = 150)

Therefore, if nitrogen is quoted at $4.00 per unit, the nitrogen in this mixture would be worth 4.5 x $4.00=$18.00. The potash at $1.00 per unit will be worth 7.5 x $1.00=$7.50, and the phosphate at the same price will be worth $6.00.

If the plant foods were sold by the pound, nitrogen might be quoted at 20 cents per pound, and potash and phosphoric acid at 5 cents, in which case the price would be as in the former example.



View of Factory, Preston, Cuba.